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प्रतिरोधिता — परीक्षण पद्धतियाँ

(पहला पुनरीक्षण)

Fire Resistance of Through
Penetration Firestops —
Method of Test

(First Revision)

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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Fire Safety Sectional Committee had been approved by the Civil Engineering Division Council.

This standard was first published in the year 1988, with a view to provide the requirements of fire resistance test of firestops intended for use in openings in fire resistance wall and/or floor-ceiling assemblies as horizontal and/or vertical stops. This revision has been brought out on the basis of experience gained over the years and to bring the requirements in line with latest developments at international level.

The following are the significant modifications incorporated in this revision:

- a) The title of the standard has been modified from 'Method of fire resistance test of firestops' to 'Fire resistance of through penetration firestops — Method of test';
- b) The standard heating condition has been updated by making a reference to IS/ISO 834-1 : 1999 'Fire resistance tests — Elements of building construction: Part 1 General requirements';
- c) Typical locations of thermocouples have been updated with an illustration depicting the same including on the unexposed side;
- d) Description of fire resistance rating and test report details have been elaborated; and
- e) The terminology section has also been updated.

The method of fire resistance test of various structural elements of buildings are covered in various parts of IS/ISO 834 with the general requirements specified in IS/ISO 834-1 : 1999. In this standard also, the requirements of test equipment have been aligned to IS/ISO 834-1 : 1999.

The composition of the Committee responsible for the formulation of this standard is given at Annex B.

In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

FIRE RESISTANCE OF THROUGH PENETRATION FIRESTOPS — METHOD OF TEST

(First Revision)

1 SCOPE

1.1 This standard specifies the method of test and determination of fire resistance rating of through penetration firestops of various materials and construction that are intended for use in openings in fire resistive wall or floor-ceiling assemblies, or both.

1.2 The standard covers the requirements to expose the firestop assembly to a standard time and temperature curve as per IS/ISO 834-1 followed by a hose stream test. Fire resistance ratings are then provided on the following criteria:

- a) Integrity, in terms of the duration of time, the firestop resists fire before the first development of through opening or flaming on the unexposed side, and acceptable performance under hose stream test.
- b) Insulation performance of the penetration sealing system, and acceptable performance under hose stream test.

1.3 This standard does not specify method of test to evaluate the influence of inclusion of penetrations and sealing systems on the load bearing capacity of the fire separating elements nor does it specify method to check suitability of firestop assemblies for use after exposure.

1.4 This standard also does not specify method of test to evaluate the ability of the firestop to withstand stresses induced by the movement or displacement of the penetrants.

NOTE — A guidance on providing engineering judgement based on test is given in Annex A for information only.

2 REFERENCES

The standards listed below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards:

<i>IS No.</i>	<i>Title</i>
IS/ISO 834-1 : 1999	Fire-resistance tests — Elements of building construction: Part 1 General requirements

IS No.

Title

903 : 1993	Specification for fire hose delivery couplings branch pipe, nozzles and nozzle spanner (<i>fourth revision</i>)
8757 : 1999	Glossary of terms associated with fire safety (<i>first revision</i>)

3 TERMINOLOGY

For the purpose of this standard, definitions given in IS 8757 and the following shall apply.

3.1 Firestop Assembly — Fire stop assembly for through penetrations is a combination of firestop compatible for use with the penetrant, such as, cables, cable trays, conduits, ducts, pipes, etc, and their means of support through the wall or opening that together restores the fire resistance rating of the fire separating elements in terms of its integrity and/or insulation properties.

3.2 Fire Separating Element — Fire resistant floors, walls and other separating elements of construction with protected opening having fire resistance determined in accordance with IS/ISO 834-1, which restrict the spread of fire.

3.3 Penetration — Aperture within a fire separating element usually present to accommodate the passage of a service through that element.

3.4 Penetrant (Penetrating Service) — Penetrating items like, cables, conduits, pipes, ducts, etc, excluding air ventilation systems and fire-rated ventilation ducts, smoke extract ducts, fire-rated service ducts and shafts, passing through the penetration in fire separating element.

3.5 Penetrant Support — The mechanical support provided in the form of clips, ties, hangers, or any other device designed to carry the load imposed by the penetrants.

3.6 Test Construction — Complete firestop assembly, consisting of the fire separating element, penetrants, penetrant support and firestop system.

4 APPARATUS

Tests shall be performed using furnace, thermocouples, restraint and support frames and other required instrumentations as per IS/ISO 834-1 and this standard.

4.1 Furnace — It shall be capable of subjecting a full size specimen individually or in combination with others in a fire rated horizontal or vertical structural element with fire resistance not less than that of the specimen to be evaluated. The periphery of firestop shall not be closer than 300 mm or 1.5 times the thickness of the test assembly, to the furnace edge, whichever is greater. The furnace shall also be capable of reproducing standard conditions of heating and pressure.

4.2 Thermocouples — Thermocouples shall be provided for measuring the internal furnace temperature and unexposed surface temperature of the firestop assembly test construction in conformity with the requirements given in IS/ISO 834-1.

4.3 Pressure Measuring Equipment — Pressure measuring equipment coupled with the furnace shall be provided in conformity with the requirements of IS/ISO 834-1.

4.4 Hose Stream Equipment — The equipment shall be provided to apply hose stream immediately after the fire exposure in conformity with the requirement of 7.3.2.

5 TEST CONDITIONS

All test conditions shall conform to the requirements given in IS/ISO 834-1, except where specified otherwise in this standard. In case a firestop assembly is intended for use in both floors and walls, then each orientation shall be tested.

5.1 Standard Heating Conditions

Standard heating conditions shall conform to the requirements given in 6.1 of IS/ISO 834-1. In addition, the requirements specified in this standard shall apply. In case of any deviation, the requirements given in this standard shall govern.

5.2 Measurement of Furnace Temperature

5.2.1 The furnace temperature is deemed to be the average of the temperatures recorded by thermocouples arranged within the furnace to give an approximation to its average temperature.

5.2.2 The number of thermocouples shall not be less than one for each 1.5 m² of surface area of walls and floors of the furnace, in which the test specimen of through cable fire penetrations firestops are installed. In any case, the number of thermocouples shall not be less than five.

5.2.3 The furnace thermometers shall be in accordance with IS/ISO 834-1 for the measurement and control of furnace temperature. It shall be uniformly distributed so as to give a reliable indication of the average gas temperature in the vicinity of heated face of the test construction. The hot junctions shall be located initially

in a plane (100 ± 10) mm from the exposed face of the separating element. In addition, no junction shall be closer than 100 mm to any projecting part of the seal, a penetrating service or any part of the furnace at the start of the test.

5.2.4 Temperature Distribution within the Furnace

At any time after the first 10 min of test, the temperature recorded by any thermocouple, shall not differ from the corresponding temperature of the standard time temperature curve by more than ± 100 °C. For specimens incorporating a significant amount of combustible material, the deviation of any one thermocouple shall not exceed 200 °C.

5.3 Measurement of Temperature at the Unexposed Side

5.3.1 Typical Thermocouple Location

Temperature measurements are to be made by thermocouples placed at each of the following locations on the unexposed side of the test sample and test assembly, as illustrated in Fig. 1.

- a) *Point A* — At a point on the surface of the test sample, 25 mm from one of each type of through-penetrating item employed in the field of the through-penetration firestop material. Thermocouples are to be covered by a pad, however, if the grouping of penetrating items through the test sample does not permit use of a pad, the thermocouple can be avoided.
- b) *Point B* — At a minimum of one point on the through-penetration firestop material surface at the periphery of the test sample.
- c) *Point C* — At least three points on the through-penetration firestop material surface approximately equidistant from a penetrating item or group of penetrating items in the field of the firestop and the periphery.
- d) *Point D* — At a point on any frame installed around the perimeter of the opening.
- e) *Point E* — At a point on the unexposed surface of the wall or floor assembly at least 0.5 m from any opening.
- f) *Point F* — At one point on each type of through-penetrating item. On each type of through-penetrating item at a point 25 mm from the unexposed surface of the test assembly. When the through-penetrating item is insulated or coated on the unexposed side, the thermocouple shall be located on the exterior surface of the insulation or coating. When the insulation or coating does not extend the full length of the penetrating item on the unexposed side, an additional thermocouple shall be installed on the penetrating item 25 mm beyond the termination of the insulation or coating.

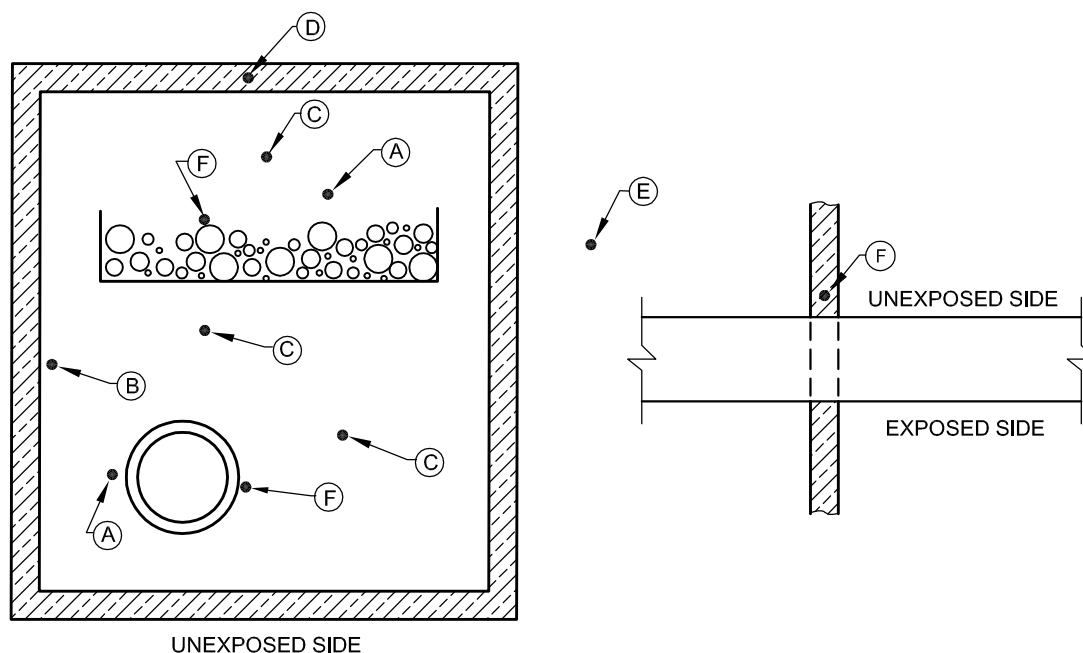


FIG. 1 TYPICAL THERMOCOUPLE LOCATIONS

- g) Temperature measurements can be made at locations in addition to those in 5.3.1 for the purpose of evaluating the performance of fire stops.

5.3.2 Temperatures shall be measured at intervals of 10 min or less until a reading exceeding 100 °C has been obtained at any one point. Thereafter, the readings can be taken more frequently at the discretion of testing personnel, but the intervals shall not be less than 5 min.

5.4 Differential Furnace Pressure Measurements

The differential pressure at the surface of the test assembly shall be measured at every minute frequency.

5.4.1 The location of the pressure sensor shall be identified where they will not be subjected to direct impact of flames and exhaust gas convection.

5.4.2 Horizontal Test Assembly

Except the first 5 min, the differential furnace pressure shall be maintained at minimum of 2.5 Pa at a distance of 300 mm from the surface of the horizontal test assembly.

5.4.3 Vertical Test Assembly

Except the first 5 min, the minimum differential furnace pressure of 2.5 Pa shall be maintained at a level of 20 mm below the lowest level of the material being tested.

5.5 Instrumentation

The control, monitoring and recording equipment necessary to carry out tests shall be in accordance with IS/ISO 834-1, except those noted herein.

6 TEST SPECIMENS

6.1 Each type of firestop assembly used as described by the construction drawing shall be tested in a higher rating fire resisting wall or floor. The penetrating items of the test sample shall be such that they extend 300 ± 25 mm from the exposed side and 900 ± 25 mm from the unexposed side.

6.2 Each ends of the penetrant are to be covered on the exposed side of the test assembly to prevent excessive transfer of gases through the test sample. When the penetrant is intended to be representative of a closed system that is not normally vented or open to the atmosphere, the penetrant can also be capped or sealed on the unexposed side. Otherwise, penetrant shall not be capped or sealed on the unexposed side.

7 TEST PROCEDURE AND RATING

7.1 General

7.1.1 The test methods described in this clause should be used to establish the effect of inclusion of fire stopped penetration in a fire separating element, on the fire resistance of that assembly. The fire may be

transmitted due to gap between joints of the penetrant/ firestop/ fire separating element, opening formed within the penetrant/ firestop, rise of temperature on the unexposed surface of the separating element in the vicinity of the penetrant, etc. These methods of transmission of fire should be considered at the time of evaluation of performance of the firestop assembly. Any failure that could lead to transmission of fire should be noted. Based on the test performed according to this standard, the fire stop assembly shall be assigned either an integrity rating only or both integrity and insulation rating (*see 7.4*).

7.1.2 The tests shall be performed only using the penetrants without the medium it is used for example, gases, fluids, etc. For evaluating performance of penetrants in service (that is, carrying gases, fluids, etc), the applicant should consult with the testing laboratory to identify the required tests.

7.2 Conditioning

7.2.1 The test construction shall be subjected to conditioning in accordance with IS/ISO 834-1, except where noted otherwise in this standard. However, with some firestop systems it is difficult or impossible to achieve such uniformity. Therefore, firestop systems shall be eligible for testing when their dampest portion has achieved a moisture content corresponding to drying to equilibrium with air in the range from 50 to 75 percent relative humidity at 23 °C. The test specimen shall be conditioned for a week.

7.2.2 The drying of the test specimen may be by natural or artificial means and a temperature of 60 °C should not be exceeded.

7.3 Procedure

7.3.1 The sample shall be tested for the rating period and shall withstand fire test without permitting the passage of flame on sustained flaming for duration of not more than 10 s on the unexposed side of the test sample. The transmission of heat resulting in raised temperature measured by any thermocouple on the unexposed surfaces of firestop shall not be more than 180 °C above its initial temperature. At the end of this test, the same sample shall be subjected to hose stream test within 10 min according to the procedure given in **7.3.2** and the sample shall not develop any opening that would permit a projection of water from the stream beyond unexposed side. Alternatively, the hose stream test can be performed on a duplicate sample subjected to fire test for half the fire rating period.

NOTE — The passage of flame is characterized by ignition of cotton, fibre pad (100 mm² × 20 mm thick of mass 3-4 g conditioned at 100 °C for 30 min) at a distance of 25 mm, *Max*.

7.3.2 Hose Stream Test

The stream is to be delivered through a 63 mm hose and discharged through a stand pipe (*see* IS 903) with water pressure and duration of application as given in Table 1. The nozzle orifice shall be 6 m from the centre of the exposed surface of the test specimen. The stream shall be directed first at one corner of the assembly and then at all other parts of the exposed face with all changes in directions being made slowly at about 1-2 m/s. The nozzle shall be moved from side to side to slowly cover the entire exposed surface. The direction shall be then changed to apply stream at 90° to the previous direction of application, by moving the stream slowly off the test construction.

Table 1 Pressure and Duration — Hose Stream Test

(Clause 7.3.2)

Sl No.	Period of Fire Test <i>t</i> , Min	Water Pressure at Base of Nozzle kPa	Duration of Application per m ² of Exposed Area S
(1)	(2)	(3)	(4)
i)	480 > <i>t</i> > 240	310	32
ii)	240 > <i>t</i> > 120	210	16
iii)	120 > <i>t</i> > 90	210	9.7
iv)	<i>t</i> < 90	210	6.5

7.3.3 During the test, the measurement and observations shall be made in accordance with IS/ISO 834-1 and the provisions of this standard. The rating shall be rounded off to the nearest completed minute of test in terms of elapsed time between the commencement of heating and the time at which the integrity and insulation criteria are no longer complied with in accordance with this standard. In addition to overall rating of the system, reporting of individual ratings like integrity rating and insulation rating separately shall be permissible. The failure of any penetrant or seal incorporated in the firestop assembly being evaluated shall constitute failure of that system.

7.4 Rating

7.4.1 Integrity Rating

It is the rating period for which the firestop test assembly is able to withstand the fire test without allowing the passage of flame or occurrence of flaming on the unexposed side of the test sample. Also, the tested firestop assembly shall not develop any openings upon subjecting to hose stream test, for the rating to be valid.

7.4.2 Insulation Rating

It is the rating period for which the temperature of the firestop test assembly measured by any thermocouple

on the unexposed surface of the firestop or on any penetrant is not more than 180°C above its initial temperature. Also, the firestop test assembly shall withstand the fire test along with hose stream test, for the rating to be valid.

8 REPORT

The test report shall include the following information:

- a) Name of the testing laboratory;
- b) Date of test;
- c) Name of the manufacturer and the trade name of the product;
- d) Description of the assembly, materials, firestop and penetrants, including drawings showing exact size of the components, and the location of firestops within the test construction, to uniquely define and identify that system and the materials;
- e) Description of the installation procedures along with information on service support system used;
- f) Description of the test procedure and test set up indicating location of thermocouples and other devices for measurement;
- g) Measurement (for example, temperature, relative humidity, pressure differential between exposed and unexposed surface, etc) and observations obtained during the test and after the furnace fire is extinguished. Observations with respect to the behavior of the firestops should include any cracks, deformation, flaming, smoke, etc; and
- h) The 'integrity rating' and/or 'insulation rating' of each firestop assembly, including statement of the performance of the firestop system with respect to integrity and/or insulation.

ANNEX A

(Clause 1.4)

GUIDANCE ON PROVIDING ENGINEERING JUDGEMENT
BASED ON TEST

A-1 When field conditions differ from original design or unanticipated construction hindrances are encountered and the field conditions cannot be easily or cost effectively redesigned, design recommendations are typically made to propose alternative methods that ensure performance of the firestop system is not compromised. These are referred to as 'Engineering Judgments or EJs' and are specified below for guidance only. Since, these recommendations are not based upon identical designs as that which were fire tested, it is important that they be developed using sound engineering principles and good judgment.

- a) Engineering Judgments (EJs) should not be used for situations where a tested system is available.
- b) Only a firestop manufacturer's qualified technical personnel or, fire protection engineer, or an independent testing agency that tests and evaluates firestop systems can issue EJs.
- c) EJs should be based upon interpolation of previously tested firestop systems that are either sufficiently similar in nature or clearly bracket the conditions upon which the judgment is to be given. Additional knowledge and technical interpretations based upon accepted engineering principles, fire science and fire testing guidelines may also be used as further support data.
- d) EJs should be accepted only for a single, specific job and project location and should not be transferred to any other job or project location without thorough and appropriate review of all aspects of the next job or location's circumstances.
- e) The test results obtained with separating elements of concrete or masonry may be applied to corresponding separating elements of greater thickness and density than that tested. The test results obtained with separating elements of lightweight concrete may be applied to concrete or masonry elements of greater thickness than that tested.
- f) The test results obtained with firestop systems tested in vertical separating elements should not be used to assess performance in horizontal elements and *vice-versa*. The anticipated effects of the expansion, contraction or deflection of structural members (floors, walls, etc) to which the firestop sealing systems are to be attached should be considered in a complete evaluation of fire performance. Additional support (if any) provided to the structural members should reflect the actual condition(s).
- g) The test results obtained using pipes apply only to the material type (combustible/non-combustible), the nominal outside diameter, the nominal wall thickness, the number and the type of the pipes that were tested. The risk of fire propagation varies with the piping material used.
- h) The test results obtained using cables apply only to the number, size and type of cables tested. The test results may be applied to single cable with smaller diameter or smaller number of cables in a bundle than tested.
- j) For providing EJs and for quality control, it should be necessary to conduct material property tests like specific heat, thermal conductivity, etc (in the temperature range associated with fires) in addition to fire resistance tests.

ANNEX B*(Foreword)***COMMITTEE COMPOSITION**

Fire Safety Sectional Committee, CED 36

<i>Organization</i>	<i>Representative(s)</i>
In personal capacity (<i>K-33, Green Park, New Delhi</i>)	SHRI S. K. DHERI (Chairman)
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Member Secretary

SHRI ARUN KUMAR
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